PALEONTOLOGY.—*The pelecypod* Euloxa: *Observations on new localities.* DAVID NICOL, *Southern Illinois University, Carbondale, Ill.*

For my first study on the monotypic genus *Euloxa*, published in 1953, only about a dozen museum specimens were available. Recently I was fortunate enough to find this rare pelecypod in the field and was thus able to observe its stratigraphic occurrence and its paleoecology. I now have 66 measurable specimens and several times that number of fragments or unmeasurable specimens from two new localities. Unfortunately, the *Euloxa* shells from both areas were friable and had to be coated with a solution of alvar and acetone.

A description of the two localities follows, and hereafter in the text they will be referred to only as locality #1 and locality #2.

Locality #1. St. Mary's formation; Hanover County, Va.; 1.5 miles south of Hanover Court House; turn west off U. S. Highway 301 on to State Route 698 to Carry Farm. This locality is a short distance south and west of Cady Station on the Chesapeake & Ohio Railroad. *Euloxa* occurs just below the dam of an artificial lake in a channel cut by the overflow of the dam.

Locality #2. St. Mary's formation; Henrico County, Va.; in a west-facing road cut on U. S. Highway 301; 0.3 mile south of Hanover-Henrico County line. *Euloxa* occurs at the base of the road cut.

These two localities are included in the distribution map of *Euloxa* (Fig. 1).

At locality #1 the thickness of the *Euloxa*-bearing bed is approximately 1 foot. At locality #2 the thickness below the base of the road cut could not be determined. At neither locality could the top or bottom of the St. Mary's formation be seen, and for this reason the position within the formation of the bed containing *Euloxa* could not be ascertained.

On the State Geological Map of Virginia (1928) the areas covered by the two localities are indicated as the Calvert formation; however, the presence of *Euloxa latisulcata*, *Chlamys* (*Lyropecten*) *santamaria*, and *Anadara idonea* proves quite

conclusively that these beds belong to the St. Mary's formation. Further paleontologic and stratigraphic work is greatly needed in this area.

PALEOECOLOGIC OBSERVATIONS

Some paleoecologic inferences can be drawn from the lithology at the two localities. The sediment at both places is exceedingly fine-grained; practically all of it could easily be washed through an 80-mesh screen. It is therefore apparent that the animals lived on a silty or muddy bottom.

Additional paleoecologic inferences can be drawn from a study of the fauna associated with *Euloxa* at the two localities, in some cases by comparing the faunas of the two places (Table 1). Because the shells are friable, it is impossible to identify many of the species, but generic and subgeneric determinations can be made. For most conclusions of a general paleoecologic nature, this amount of systematic allocation is adequate.

Some of the species from both localities appear to be indigenous; other species, by their rare occurrence and poor preservation, appear to have been washed into these areas after death. The latter have been marked with an asterisk in the faunal list and can be omitted from any serious consideration of the ecology at the two localities. This eliminates 10 of the 39 species found at the two places.

At both localities the faunal assemblages are typically marine. A study of the pelecypods (data taken from Keen and Frizzell, 1953, pp. 23–25, and substantiated by Thorson, 1957, pp. 508, 514) indicates that the depth of the water was probably not less than 7 m and not more than 40 m at either locality. A further indication of depth is the presence of the brachiopod genus *Discinisca*, which in modern seas is confined to shallow water.

In terms of number of species, pelecypods predominate at both localities. In number

of specimens, however, gastropods (virtually all *Turritella plebeia*) are almost as numerous at locality ✳ 1 as are pelecypods there. The almost total lack of gastropods at locality ✳ 2 and the lack of variety of gastropods at locality ✳ 1 are probably due to the fact that gastropods do not thrive on a silty substrate. Dr. F. M. Bayer (oral communication) corroborates this statement. His studies of living mollusks reveal that few species of gastropods live on fine mud bottoms, although in such environments the few existing gastropod species may be represented by many individuals.

There is some evidence of carniverous gastropod activity at both localities, but no shells of this type of gastropod were found. At locality ✳ 1 one specimen of *Anadara* and four specimens of *Euloxa* had holes in their shells drilled by carniverous gastropods. At locality ✳ 2, which had a smaller number of pelecypods, more shells had been attacked by gastropods—one *Mercenaria*, one *Euloxa*, two *Eucrassatella*, and five *Spisula* (*Hemimactra*). Clionid sponge borings in the shells of *Chlamys*

are also common at locality ✳ 2 but very rare at locality ✳ 1.

It is particularly noticeable at locality ✳ 1 that the faunal elements are in general represented by small or thin-shelled forms or both. Such genera as *Discinisca, Dentalium, Turritella, Nucula, Hiatella, Semele*, and *Glossus* all fit this description in one or both respects. At locality ✳ 1 this leaves only *Anadara*, which is rare, and *Euloxa*, which is common but is only medium-sized. It has been my observation, as well as that of Dr. Bayer, that large, heavy-shelled mollusks are rarely found on a mucky or silty bottom. At locality ✳ 2, where apparently the silty conditions were not so extreme, there are more specimens of large or thick-shelled mollusks: *Euloxa*, which is common, and *Anadara, Chione*, and *Eucrassatella*, which are rare. They are greatly outnumbered by small or thin-shelled forms, such as *Dentalium, Turritella, Chlamys, Pododesmus, Spisula* (*Hemimactra*), *Corbula*, and *Panope*. The reasons that large, thick-shelled mollusks do not live on a silty substrate are probably mechanical ones.
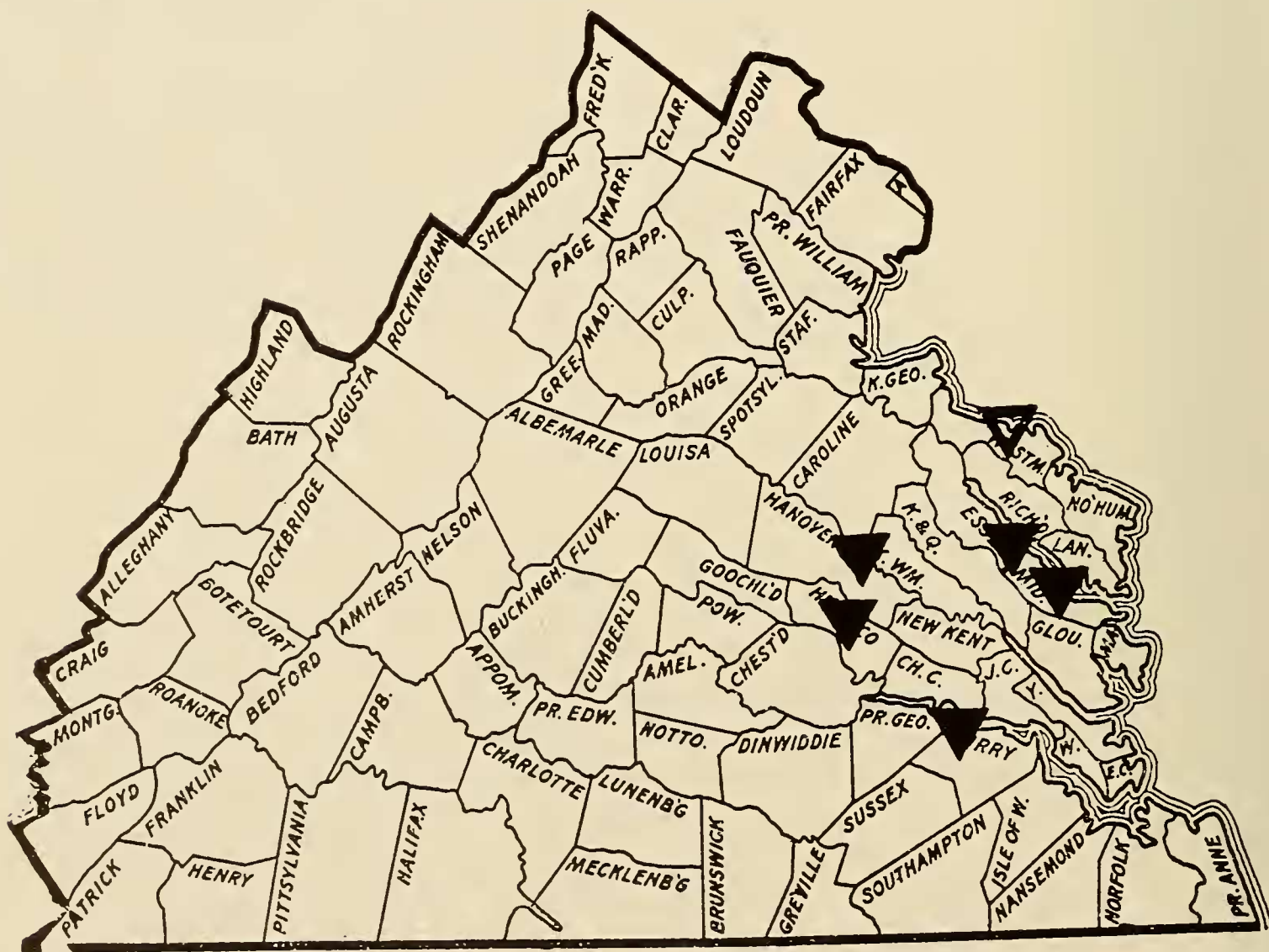

Fig. 1.—Map of part of Virginia showing general localities where *Euloxa* has been reported. Solid triangles, specimens examined by me from these localities. Open triangle, specimens reported from this locality in literature.

Table 1.—List of Fauna from the Two Localities

(Asterisk indicates those which were probably washed in after death.)

(Sequence of terms: Abundant, common, rare, very rare.)

Species	Locality #1	Locality #2
Anadara idonea (Conrad)	Rare	Rare
Balanus sp.	*Very rare	*Very rare
Cerastoderma sp.	*Very rare	—
Chione sp.	*Rare	Rare
Chlamys (Lyropecten) santamaria Tucker	Common	Common
Clionid sp.	Very rare	Common
Coral	—	Very rare
Corbula (Caryocorbula) inaequalis Say	Common	Rare
Dentalium attenuatum Say	Common	Rare
Discinisca lugubris (Conrad)	Common	—
Ecphora sp.	*Very rare	—
Eucrassatella sp.	—	Rare
Euloxa latisulcata (Conrad)	Common	Common
Glossus sp.	Very rare	—
Hiatella arctica (Linné)	Very rare	—
Isognomon maxillata (Deshayes)	*Very rare	—
Mercenaria sp.	*Rare	*Very rare
Nucula proxima Say	Abundant	—
Pandora sp.	Rare	—
Panope sp.	—	Rare
Parvilucina crenulata (Conrad)	Rare	—
Pitar sp.	*Very rare	*Very rare
Pododesmus (Monia?) philippi Gardner	Common	Very rare
Semele sp.	Very rare	—
Spisula (Hemimactra) sp.	Rare	Abundant
Turritella plebeia Say	Abundant	Rare

Another observation should be noted. Even in genera like Chlamys and Spisula, the representatives at both localities tend to run to small size. In the case of Chlamys (Lyropecten) santamaria this is not inherent in the species; specimens collected from a more favorable environment sometimes become twice as large. In the case of Spisula (Hemimactra) species, there are few relatively large specimens from localty #2 and none from locality #1.

The dominant elements of the fauna at locality #1 are Turritella plebeia and Nucula proxima; at locality #2, a few miles away and with very similar lithology, Turritella plebeia is rare and Nucula proxima is absent. The dominant fossil at locality #2 is Spisula (Hemimactra) species; yet this form is rare at locality #1. Among the less abundantly represented species there are, also, many discrepancies between the two localities. At locality #1 the brachiopod Discinisca lugubris is rather common, but not one specimen occurs at locality #2. Pododesmus (Monia?) philippi and Corbula (Caryocorbula) inaequalis are much more common at locality #1 than at locality #2. In addition, Pandora, Parvilucina, Hiatella, Semele, and Glossus, are represented by few specimens at locality #1, Parvilucina being the most common, but are absent at locality #2. The reverse is true of Panope and the thick-shelled genus Eucrassatella, a few specimens having been found at locality #2 but none at locality #1.

What are the reasons for these faunal differences? That there was little or no dissimilarity in geologic time is indicated by the fact that the genus Euloxa, found in the same beds, had only a short life span, probably less than one million years. (See Nicol, 1953a, pp. 706–707.) The differences could be due, at least in part, to the condition of the substrates; i.e., although the matrix is fine-grained at both places, the sediment at locality #2 comprises much more shell material and even the bottom may have been firmer there than at locality #1. The abundance or scarcity of shell material, as well as the matrix itself, is a vital determinant of the type of benthonic animal which will live in an area, and this factor must therefore be taken into consideration when the paleoecology of a locality is studied. Although the depth of the water was probably not more than 40 m at either locality, there may have been enough difference in water depth to contribute to the dissimilarity in the faunal elements of the localities. One other factor may have played a part in the faunal discrepancies. Brachiopods, as exemplified in these two faunas only by Discinisca lugubris, are, in general, gregarious animals. This same gregarious habit may occur in some of the

mollusks as well and would explain the presence or absence of a species at a particular locality. There is no evidence that temperature of the water was a factor in the faunal differences between the two localities.

OBSERVATIONS ON EULOXA

Euloxa latisulcata was probably not adapted too well to the conditions on a muddy bottom because all indications so far point to a period of existence for this species of less than one million years. This is a very short life span for a pelecypod species and an extremely short life span for a pelecypod genus. Within the two populations of *Euloxa latisulcata* that I have examined there was a large number of small or immature specimens, many of which were not recovered from the matrix because of their thin and fragile shells. I estimate that 50 per cent of the shells of *Euloxa latisulcata* that I saw were less than 12 mm long, and the largest measurable specimen was 25.8 mm long.

The well-preserved specimens of *Euloxa latisulcata* show distinct seasonal (most likely annual) growth rings on the outside of the shell. The greatest number of growth rings is eight. Most large specimens (20 or more mm in length) have five or six. Specimens of less than 10 mm in length show no growth rings. The latter probably never reached sexual maturity, and perhaps the specimens with only one growth ring also did not.

The nearest living relative to *Euloxa latisulcata* on which I have discovered any data on the matter of reproduction is *Mercenaria mercenaria*. Like many other pelecypods this bivalve is a protandric hermaphrodite—the young specimens nearly always being first male. After the sperm are shed into the water, about half of the population of young individuals becomes female. (See Loosanoff, 1936.) If *Euloxa latisulcata* reproduced in the same manner and if at some time there was a preponderance of sexually immature individuals and males, the survival of the species must have depended on the number of sexually mature females. When the latter group became too small in number, (the growth-ring data indicate that many died before sexual maturity) the species became extinct. This may not be the reason that *Euloxa latisulcata* survived for less than one million years, but, on the other hand, it is a possibility, and it is presented here merely as that. No other reason, backed by any evidence, can be presented at this time.

Some new morphological data, based on examination of a much larger number of specimens, can be added to the observations that I made in my earlier paper. The average specimen is 2 mm longer than high, and even small specimens (less than 12 mm in length) are nearly 2 mm longer than they are high. There is more variation in large specimens (more than 20 mm in length) in the height-length ratio. Some specimens are more than 4 mm longer than high while one specimen has the same height and length measurements. The convexity averages 64 per cent of the length, but this percentage is slightly higher in large specimens. The average height for 68 specimens is 17.0 mm, the length 19.0 mm, and the convexity 12.1 mm. The maximum height observed was 22.4 mm, the length 25.8 mm, and convexity 15.4 mm. Each of these maximum measurements was found on a different specimen. No gerontic individuals were found.

The outline of the valves varies from subquadrate to subcircular. Small specimens generally have a more truncated posterior side. On some specimens, in front of the prominent sulcus on the posterior fifth of the shell, is a faint shallow depression which is wider and more marked toward the ventral border. A similar type of depressed area in about the same area on the outside of the shell, although somewhat larger, is seen in some chionid species.

The anterior pedal retractor muscle scar is small but well marked. It is located under the hinge plate dorsally and slightly posterior to the anterior adductor muscle.

On all large specimens and on most smaller ones, tooth 1 in the right valve is triangular and robust, and it lies perpendicular to the dorsal margin. However, in some of the smaller specimens this tooth is elongate and lies nearly parallel to the

dorsal margin. Apparently the anterior extension of tooth 1 disappears as the individual increases in size.

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RETARDATION OF COPPER CORROSION BY LIGHT

Sunlight or other intense light, which ordinarily accelerates the corrosion process in metals, has been found to produce an opposite effect on copper oxidation[1]—copper oxide growth is actually retarded by the irradiation. This unusual behavior was observed at the National Bureau of Standards as part of a continuing research project on the corrosion of copper over a wide range of controlled conditions.

In the present investigation, which was partially sponsored by the Corrosion Research Council, Dr. Jerome Kruger of the Bureau's corrosion laboratory immersed copper single crystals in water and found that irradiation retarded subsequent copper oxide growth. Single copper crystals were used because their relatively simple structure gives results that are more easily calculated and understood.

The copper crystals, which were grown from copper of 99.99 percent purity, were submerged in air-saturated, distilled water. A water-jacketed container was used to maintain a constant temperature and to avoid overheating due to intense light. All light was excluded from the highly polished copper crystal except that which shone through a small aperture in the jacket.

After three hours of uniform illumination at room temperature by 3200°K tungsten lamp, the entire crystal sphere was found to be much less oxidized than when illuminated by room light. To study this effect further, one-half of the crystal was illuminated with the intense white light from the tungsten lamp. It was found that the irradiated portion had oxidized at a markedly different rate than the unilluminated area. An electrometric measuring technique showed a film thickness of 120 A on the exposed side and an average film thickness of 500 A on the other side.

When similar light was allowed to impinge on part of a crystal already coated with a thick film (1000–2000 A), the oxide on the illuminated portion became considerably thinner than on the unexposed part of the crystal. X-ray diffraction studies of the films found on both the dark and the irradiated parts of the crystal showed that the films were composed of well-oriented cuprous oxide.

Although the mechanism for this behavior is not known, a possible explanation is a copper-cuprous oxide photocell theory, which centers upon the semiconductance of cuprous oxide. Irradiation would cause an electron flow from the cation-deficient semiconductor film of CU_2O into the metal. This direction of flow is just opposite to that during oxide growth and hence could block further propagation of the oxide. Other investigators[2,3] have found that light favors oxidation of aluminum and tantalum whose oxides are cation-excess semiconductors.

The present study indicates that there is a direct correlation between the rate of the oxide formation in water and the underlying crystal structures. Crystallographic orientation studies are now in progress to verify this.

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